MUSEUM OF INTERFACE

Designing the Virtual Environment

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Abstract. A virtual environment (VE) has been designed for functioning as a three-dimensional interface to a repository of images and sounds. This paper attempts to study design interface in VEs. This study first examines the characteristics of VEs. The difference between physical and virtual environments is also studied. The relationship between both is classified as three types, i.e. complement, replacement, or independence. Then it establishes the design interface in VEs, and presents an experimental project, the virtual architecture museum (VAM). Four elements of VEs are highlighted, i.e. wayfinding, linkage, context, and atmosphere. In VAM, the interface is implemented on the web and is integrated with an architectural database. It is found that the appropriateness of design interface can enhance the users' spatial awareness, and consequently facilitate the task of navigation and wayfinding within VEs. The context and atmosphere of VEs can be defined by means of simile or metaphor through the visual or acoustic experience for gaining senses of a place.

1. Introduction

The increasing growth of the internet and the development of virtual reality (VR) technologies have become the impetus for developing the cyberspace (Baker 1993). In the information age, the traditional definition and characteristics of space or architecture are also transformed by computers and the internet into virtual environments such as virtual architecture (Zampi and Morgan 1995), digital architecture (Bertol 1997), visionary architecture (Thomsen 1994), or hyper architecture (Puglisi 1999).

A virtual environment (VE) has been designed for functioning as a three-dimensional interface to a repository of images and sounds (Bridge and Charitos 1997). These can include web-based HTML or VRML representations, immerse VR or simple text-based description for individual browsing or group interaction. However, VEs as a medium for creating synthetic or interactive

experiences are still in their infancy (Bridge and Charitos 1997, Chiu 1997). To enhance users' spatial awareness, and consequently facilitate the task of navigation and wayfinding within VEs, it is necessary to study the characteristics of VEs and aspects of design in creating VEs.

Therefore, this paper attempts to study design interface in virtual environments. Three tasks are undertaken to: (1) examine the characteristics of VEs, the structure of cyberspace, and the difference between physical and virtual environment; (2) establish the design interface in VEs, such as wayfinding, linkage, context, and atmosphere; and (3) demonstrate an experimental project, the virtual architecture museum (VAM), for further discussion.

1.1. DEFINING VIRTUAL ENVIRONMENTS

"Reality" generally means the physical presence of objects, or actual state of objects. On the contrary, "virtual" means unreal or composition of non-atomic, non-biological objects, or scenes generated by simulation. In this paper, we are using virtual environments in contrast to physical environments. The following should clarify the vocabulary used in the paper:

- Environment is referred to a series of status or events around people whom can perceive and interact with. It is also referred to the circumstances or conditions that surround one.
- Atmosphere is referred to an aesthetic quality or effect, especially a distinctive and pleasing one, associated with a particular place.
- Context means the correlated environments or states in which events occur.
- Cyberspace is an information space connected by a computer network of information channels (McFadden 1994, Benediket 1991).
- Orientation means placing oneself in relationship to point of the compass or a reference system (Cheng 1998).
- Navigation is the theory and practice of making one's way through space (Stuart 1996).
- Wayfinding is the act of using spatial perception and navigational awareness to reach a destination.
- Virtual environments (VEs) is defined as "An environment is that which surroundings participants, the set of conditions and objects participants can perceive and with which participants can interact." (Stuart 1996)

2. The Characteristics of VEs

In the past, the development of VEs is driven by the technological advances by applying VR to design representation. While the approach is nature, the outcomes neither result in unique essence or effect though not as same as the actual form, nor inspire designers' new development or creativity. Therefore, we like to start

examining the characteristics of VEs to explore the possibilities in creating VEs. The emergence of cyberspace and the differences between physical and virtual environments are studied as follows.

2.1. THE EMERGENCE OF CYBERSPACE

Cyberspace is the virtual space of computer memory and networks, telecommunications and digital media. The foundations of the cyberspace infrastructure were established as long ago as the 1830s with the development of the electric telegraphy. The most recent developments in cyberspace stem from the linking of computers to the telephone system. In the 1980s, Cyberspace is coined by William Gibson's science fiction "Neuromancer", referring to the interconnected web of databases, telecommunication links and computer networks which perceptually seem to constitute a new space for human communication and action (Cotton and Oliver 1994).

Wertheim (1999) describes the change of spatial concepts from the fourteenth century Dante's "La Divine Comedia" to the Internet. "Virtual" reality is not a new concept, but a social phenomenon for visual communication. As we can see now, cyberspace and digital media gradually influences our daily life. The proverb "We make our buildings and our buildings make us." as described by Winston Churchill, is possibly transformed into "We make the Internet and the Internet make us."

2.2. PHYSICAL VS. VIRTUAL SPACES

Traditionally, places or space rely on buildings or their interior facilities to support various functions. After the emergence of computers and the internet, technologies are gradually transforming or replacing the arrangement in space or buildings. We can easily find many evidences to support the argument of these changes. For example, Mitchell (1995) indicates the difference between the atomic space and the bit space in "City of bits", and initiates the concept of "programmable space". Relying on software and information flow of bits, architecture is therefore no longer to be fixed permanently, and its definition and domain becomes vague. When computer decomposes the traditional architectural form and space, new kind of space are emerged and rearranged. Therefore, many forms of VEs are created, such as virtual banks, malls, museums, galleries, bookstores, libraries, schools, or governments. Meanwhile, virtual design teams, enterprises, or servers are emerged.

The physical environments have natural constraints such as daylight, wind, gravity, and geometric boundary. While without natural constraints, the development of VEs is subject to the psychological as well as technological factors. The meaning of artifacts in both spaces are varied. Indeed, the physical space can be directly transformed into virtual space by representing the exact

scenes. Nevertheless, the relationships between physical and virtual space are changed. Three kinds of relationship can be found in the present development of VEs.

1. The virtual space is identical to the physical space; therefore, the virtual space can replace the physical environment.
2. The virtual space is a complement to the physical space; therefore, each can be complementary function to each other.
3. The virtual space is independent from the physical space; therefore, the virtual space can create new experiences that differ from the existing one.

3. The Spatial Structures of VE

In this section, the spatial structure and types of VEs are studied to examine the about above relations, and the roles of users, information, and space.

3.1. THE STRUCTURE OF VE

The structure of cyberspace is described as an input-output device consisting of components for information transmission in a Shannon-type information theory, which has an information source and an information receiver. (McFadden 1994, Shannon and Weaver 1963) The path connects the nodes that can be a web page or a VRML model for transmitting information. Figure 1 demonstrates three typical network topologies and the hybrid one. These constitute the archetypes of VEs. In the physical space, the linkages provide the necessary circulation and orientation, Figure 2. The abstraction of linkages can be transformed into VEs.

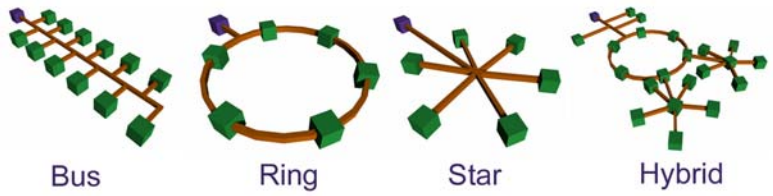


Figure 1. Typical Network Topologies

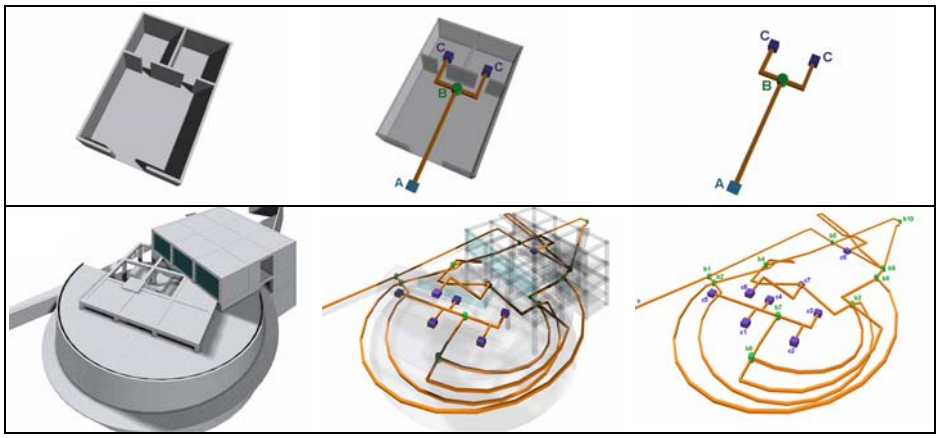


Figure 2. The linkages in physical spaces

TABLE 1. Comparison of the real and virtual Museum

			Real Museum	Virtual Museum
Definition			To display collections, and provide educational and research functions.	To provide exhibition, education, and research functions by digital media.
Comparison	Users	1.Autonomy	Be passively guided	Play an active role
		2.Control ability	Cannot control or change the setting in environment	Can change views or objects by interactive interface.
		3.Social experience	Social functions are important.	Social functions disappear (but should be provided.)
	Inform-ation	1.Exhibition	Generally can be displayed in a single and fixed platform.	Can be displayed in multiple platforms according to users or request on demand
		2.Representa-tion	Real objects (the traditional approach)	Digital movies, data, models (can without real objects)
	Space	1.Size/scale	The capacity is limited by the physical space, require large space for preservation.	The capacity is subject to the volume of server and network bandwidth. Can be small.
		2.Observation distance	To be limited by the distance between the observers and subjects.	Can be adjustable in according with the user demand.
		3.Organization	Circulation defines the organizational hierarchy.	Hyperlinks change the absolute spatial relationship and circulation.
Substitution and transformation of elements			1. storage space	1. server/network
			2. display corridor	2. hyperlink or models
			3. display windows	3. computer display
			4. physical objects	4. digital information

3.2. REAL VS. VIRTUAL MUSEUM

This study has compared different types of VEs in comparison with physical environments, such as virtual museums, galleries, libraries, bookstores, banks, and department stores. For example, we compare the real and virtual museums, Table 1, and help understanding the relationship and the needs for design interface in VEs. Particularly, we are inspired by the inquiries about the causes and forms of the possible substitution or transformation of elements for developing VEs. The context and atmosphere, or the sense of places, are found to be critical to VEs. Users can play active roles and have more control abilities to access multiple representations of information in VEs. Nevertheless, the social function is still critical in both environments. The design of VEs should concern about the psychological factors as well as the technical factors.

4. Design Interface

VEs rely on software to generate the virtual world, and hardware to compute and interact with human beings. Bridge and Charitos (1997) indicates the designing virtual environment requires the spatial elements in VEs, such as places, paths, domains, and thresholds. The design interface can increase the user spatial awareness of VE, interact with VEs, control objects within VEs, or even enhance the spatial experience or the sense of places by orientation/wayfinding, linkage, context, and atmosphere, as described below.

4.1. ORIENTATION / WAYFINDING

The spatial orientation or a more appropriate term "wayfinding" is critical to user awareness of environmental information, including general, locational, or time description. Labyrinthic designs can lead to disorientation (Passini 1984). Wayfinding is critical to user spatial awareness of VEs to locate the position, and requires (1) orientation, (2) a plan to proceed, and then (3) means for proceeding (Cheng 1998). Satalich (1994) indicates that interface for wayfinding can be in various approaches such as self-exploration, active guided, passive guided, or control; and users would prefer an arrow to indicate both position and orientation. Traditional wayfinding methods such as using signs, symbols, or maps are often applied to the VEs because of users' cognitive perception of environmental information.

Hyperspace can has one or more dimensions in according with the needs of representations in VEs. The object identity is critical to user perception; therefore, the objects and scenes in VEs can be configured as three kinds of representations, i.e. information icons, flows, or landscape, as shown in Figure 3. The locating function as computer query of (x,y,z) coordinates can be integrated into a hidden

grid system, compass, digital maps, or other information landscape created in digital forms.

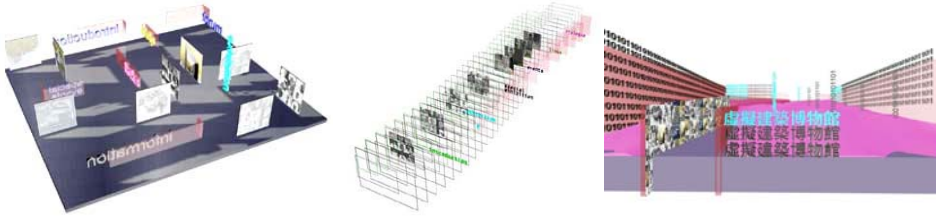


Figure 3. Three kinds of information representation in VEs

4.2. LINKAGES

Hyperlink is probably the most important element in cyberspace. Linkage is a connection of related objects and scenes that provide the orientational information. While linkage and orientation is related, this issue is focusing on the route/path, connection nodes, and the hierarchy of space. After determining where one is in respect to nearby objects and the target location in VEs, users need to make route decisions, i.e., choose a route that will get one to their destination. The nodes are linked by direct path with physical connections, while Chinese landscape architecture are purposely designed with indirect path and the nodes are linked by metaphors for perceiving implicit meanings. Users can detect the connection node by images or icons that the uniformed resource locator (URL) is specified for linking related web pages or VRML models.

4.3. CONTEXT / SIMILE/ METAPHORS

VEs can be decomposed into various objects and scenes in accordance with the contexts that associated with various events occurred in the related environment or states. In VEs, objects consist of artifacts, controls, and agents. Observers can perceive the focuses and implicit intentions from the scenes. Figure 4 demonstrates three scenes of a gallery with lighting, artifacts, or/and agents. These are often rendered with texture mapping to reveal simile or metaphors. In VEs, metaphors can be presented by various forms without physical restrictions.

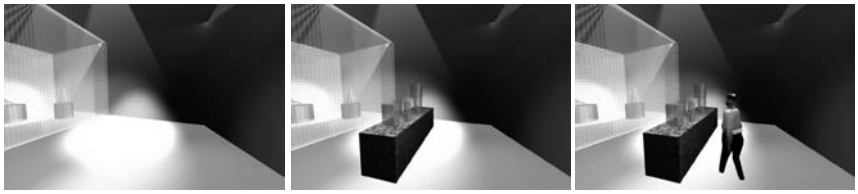


Figure 4. Scenes with lighting, artifacts, or/and agents

4.4. ATMOSPHERE / SENSE OF PLACES

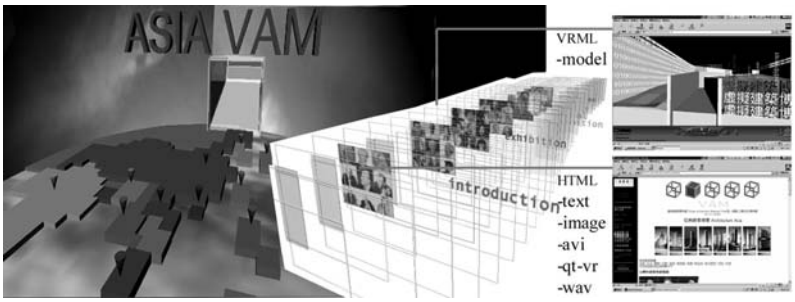
People can recognize their living place because they can perceive the atmosphere in the appearing environment under the background or setting in the circumstance of place, timing, people or life style. In additional to visual information, users can perceive the atmosphere or the sense of place from the background sound, the smell, and the actions. While current VR technologies enable the imitation of all possible human sensors, visual and acoustic information constitutes the major environmental information.

5. Virtual Architectural Museum

Architecture is created as a place based on the needs or program through meaningful spatial definition and arrangement (Ching 1979). Similarly, in virtual architectural design, designers define the main content, characteristics and conditions of space based on system analysis. In this section, the virtual architecture museum (VAM) is presented to demonstrate the important characteristics of VEs as indicated, and how the users interact with VAM.

5.1. CONTENTS OF VAM

VAM is implemented on the web as an architectural database consisting of the background history, major famous architects, and recent projects in Asia after the modernism. VAM is to provide traditional functions such as exhibition, workshops, education and research as well as new functions such as online services, and its shell is integrated with HTML, JAVA, and VRML. Its interface can define the 3D model, and simulate and generate some interactive relations in VEs. Figure 5 demonstrates the design interface in VAM. For example, the Asia map is created as an information landscape which users can navigate or decide the destination, then search items in information flows through VRML-based models to link HTML-based web pages for details.



URL: http://www.arch.ncku.edu.tw/vam/index.htm

Figure 5. Design interface in VAM

5.2. INTERACTION AND REFLECTION

The primary audience of VAM is the architectural professions and students who can visually search information by query to access various categories. While each group is addressing different interests, VAM is designed to serve as a platform for dialogue among interest groups. Therefore, information services are critical needed. We have seen many VEs as information providers and ignoring the social functions, and argue that virtual museums should be a place for gathering information and ideas, instead of artifacts that were normally kept in the traditional museums. Therefore, its social function will not be disappeared, but rather be enhanced in another form on the web.

It is found that the appropriateness of design interface can enhance the users' spatial awareness, and consequently facilitate the task of navigation and wayfinding within VEs. Chiu (1999) indicates the interaction between the user and the VEs can be in different modes such as the user, agent, monitor, or immersion mode for different purposes. Nevertheless, we need more in-depth behavioral studies to answer questions such as how critical is spatial awareness in VEs? how important is 3D representation of architectural information? or how to initiate social interaction among interest groups?

6. Discussion

The demonstration project provides some directions for future development in virtual environments. Space can be decomposed and reassembled in VEs. Traditional navigational behaviors such as walkthrough in a fixed program will be changed, and users can even specify their interests, overview the museum resources and define their own programs. Apparently, VEs' social functions should be enhanced, and require new forms of places for exchanging ideas and thoughts in addition to current communication channels such as Chat, MUD/MOO, NetMeeting, etc. The themes among the professional community or the society can be posted and discussed, and the space can be programmed. Furthermore, an internet-based design culture can be emerged to shared information and experience, public opinions, and comments.

As many VR applications are developed, we may reach the point where the boundary between physical reality and virtual reality blurs. When architects try to image and create the most possibilities in the finite space, VE designers are defining the characteristics of VEs in infinite space. Meanwhile, the creation of a new view of reality is, in itself, an exciting step in human evolution. We are beginning to understand some of the simplest laws of nature as they are manifest in the creatures and environment around us (Krueger 1991).

In conclusion, this paper provides a basic understanding of how VEs can be created as "programmable spaces" with special features to highlight the above discussion. The relationship between physical and virtual environments is

classified as three types, i.e. complement, replacement, or independence. Each presents different meanings to users since we are always socially situated. When the potential uses of VEs in the real world, the process of planning, design, and construction can be affected by the VR technology quickly, and the influence will be visible. However, the social interaction requires more in-depth studies.

References

Baker, R.: 1993, *Designing the Future - The Computer Transformation of Reality*, Thames and Hudson, Hong Kong

Benediket, M. (ed.): 1991, *Cyberspace: First Steps*, The MIT Press

Bertol, D.: 1997, *Designing Digital Space - An Architect's Guide to Virtual Reality*, John Wiley

Bridge, A. and Charitos, D.: 1997, The Architectural Design of Virtual Environments, in R. Judge (ed.), the proceedings of CAAD Future '97, Munich, Germany, p.719-732, Kluwer Academic Publishers

Campell, D.: 1996, Design in Virtual Environments Using Architectural Metaphor: A HIT Lab Gallery, University of Washington, Seattle

Cheng, N.Y.: 1998, Wayfinding in Cyberspace: Negotiating Connection Between Sites, in Sasada, T. (ed.), Proceedings of the third conference on Computer Aided Architectural Design and Research in Asia, p.82-92

Ching, F.D.K., 1979, *Form, Space & Order*, Van Nostrand Reinhold, NewYork

Chiu, M.L.: 1999, Design Navigation and Construction Simulation by Virtual Reality, in the proceeding of the Fourth International Conference of CAADRIA'99, Shanghai, China, p.31-41

Chiu, M.L., Lan, J.H.: 1998, Discovery of Historical Tainan: A Digital Approach, in the proceeding of the Third International Conference of CAADRIA'98, Osaka, Japan, p.113-122

Chiu, M.L.: 1997, Transforming The Reality into Virtual Reality - The Influence of Computer Simulation Technologies on the Built Environment, proceedings of The Seventh International Conference of ICCCBE, Vol. 1, Seoul, Korea, p.659-664, Techno-Press

Cotton, B. and R. Oliver: 1994, *The Cyberspace Lexicon*, Phaidon Press Ltd., London

Krueger, K.W.: 1991, *Artificial Reality II*, Addison-Wesley

McFadden, T.: 1994, Notes on the structure of cyberspace and the Ballistic Actors Model, in M. Benedikt (ed.), *Cyberspace: First Steps*, p.335-362, The MIT Press

Mitchell, W.: 1995, *City of Bits: Space, Place, and the Infobahn*, The MIT Press

Passini, R.: 1992, *Wayfinding in Architecture*, Van Nostrand Reinhold, New York

Puglisi, L.P.: 1999, *Hyper Architecture – Spaces in the Electronic Age*, Birkhauser, Basel

Schmitt, G.: 1993, *Architectura et Machina - Computer Aided Architectural Design und Virtuelle Architektur*, Vieweg, Germany

Shannon, C. and Weaver, W.: 1963, *The Mathematics Theory of Communication*, Urbana, The University of Illinois Press

Satalich, G.A.: 1994, *Navigation and Wayfinding in Virtual Reality: Finding Proper Tools and Cues to Enhance Navigation Awareness*, University of Washington, Seattle, <http://www.hitl.washington.edu/publications/satalich/home.html>

Stuart, R.: 1996, *The Design of Virtual Environment*, McGraw-Hill, New York

Thomsen, C.W.: 1994, *Visionary Architecture - From Babylon to Virtual Reality*, Prestel, Munich

Wertheim, M., 1999, *The Pearly Gates of Cyberspace: A History of Space from Dante to the Internet*, W.W. Norton & Company

Zampi, G. and Morgan, C.L.: 1995, *Virtual Architecture*, Batsford, London